

ENVIRONMENTAL ASSESSMENT

Evaluation of Ungulate Impacts to Park Resources

A RESEARCH PROJECT USING ENCLOSURES

August 1, 1997

BANDELIER NATIONAL MONUMENT

National Park Service
Department of the Interior

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Introduction

Bandelier National Monument was originally established to protect and preserve archeological resources. During the past 60 years, national legislation has expanded that mission to include protection and preservation of natural resources as well. Today, large numbers of elk (*Cervus elaphus*) and deer (*Odocoileus hemionus*) are causing visible damage to both cultural and natural resources in the park.

Elk numbers have increased dramatically during the last 30 years in and near Bandelier National Monument. Within the park, deer have been reported at habitat-damaging levels since at least the 1950's. Heavy grazing and browsing by elk and deer are apparent on several plant species. Removal of plant material by elk and deer along with associated soil trampling appear to be changing forest and grassland structure, changing habitat compositions, contributing to losses of cultural resources, and magnifying high erosion rates in piñon (*Pinus edulis*)-juniper (*Juniperus* spp.) habitats.

Significant resource loss may result if the observed trends continue in the future. Before potential actions and alternatives can be identified, however, objective and quantitative information is needed.

A study approach using replicated ungulate exclosures and vegetation reference sites is proposed. Measurements at both the exclosures and reference sites will record soil surface cover; tree and scrub cover; grass and forb standing biomass and annual biomass production; forb and shrub reproduction and vigor; and measures of insect, small mammal and bird usage. Population indices for elk and deer will also be determined based on pellet-group counts.

The accumulated data will provide information on the current level of plant utilization by ungulates, damage to plants due to trampling by ungulates, impacts to cultural resources, and effects on insect, small mammal, and bird populations. This information will be used to determine long-term sustainable ungulate population levels relative to the current level.

Purpose of and Need for Action

There is no evidence that elk were ever abundant during prehistoric or historic time in the Bandelier area (Allen 1996). Out of a total of 218 ungulate individuals identified from 45 local archeological sites, only three individual elk were determined, based on nine elk bones. Eight of these bones date from the late 1800's, while the ninth was a 15th Century bone tool which might easily have been imported. Thus, elk presence was at most only low or moderate from ca. 1150-1500 AD (Allen 1996). Historic observations suggest elk were scarce in the Jemez Mountains area before 1900, becoming extirpated around the turn of the century (Henderson and Harrington 1914, Findley 1987).

In 1948, the New Mexico Department of Game and Fish (NMGF) released 21 cows / calves and 7 bulls of Rocky Mountain elk into the Jemez Mountains. These animals were brought in from Yellowstone National Park (Keefe 1948). By 1961, NMGF estimated a population of approximately 200 elk in the Jemez Mountains, all descendants of the 28 founders. From 1948-1965, elk were rarely seen in Bandelier, with park population estimates ranging from 0 to 6 individuals (Bandelier annual wildlife reports).

Over the past three decades, elk in the Jemez Mountains have exhibited exponential population growth. From the 1961 estimate of 200 animals, the population grew to an estimated 1989 level of 6000-8000 individuals. This remains the current NMGF population estimates (Isler pers. comm.). For the period 1948-1992, given the increase from 28 elk to a conservative current estimate of 6000 elk, the calculated annual growth rate for the Jemez Mountain elk herd is 13 percent, with a doubling time of 5.7 years. Since the 1977 La Mesa Fire, wintering elk numbers have similarly increased dramatically in the Bandelier area (Allen 1996). Observations over the past four years reveal that local elk populations continue to colonize lower elevation sites in ever-increasing numbers, likely indicating continued population growth.

Elk can inflict considerable damage to plants, particularly to aspen (*Populus tremuloides*) by eating the bark in winter or by direct browsing of regenerating shoots (DeByle 1985). Fieldwork documented significant elk de-barking at 90 of 269 points (33%) sampled in 1987 where aspen was present in the Frijoles watershed (Allen 1989). Aspen stands are now being de-barked by elk throughout most of the eastern half of the Jemez Mountains. In several places on Apache Mesa in Bandelier, aspen stands that resprouted after the La Mesa Fire have been browsed by elk to an

extent that the continued survival of the aspen clones appears questionable.

There are several other lines of visual evidence that suggest elk are negatively impacting the park's vegetation, especially in piñon-juniper woodland and ponderosa pine grasslands. Shattered rosettes of banana yucca record one food selected by elk from piñon-juniper woodlands. The stature of *Holodiscus dumosus* in open grasslands has been limited by browsing since 1984 on Cerro Grande. *Ceanothus fendleri* is browsed in the La Mesa burn areas used by elk. Elk antler-rubs are slowing tree establishment in the La Mesa Fire burn area (Allen 1989). Due to these observations, a concern has developed that the depauperate herbaceous vegetation of piñon-juniper woodlands and ponderosa pine grassland is now partly attributable to elk grazing.

It is generally believed that the initiation of intensive grazing by domestic livestock in the late 1800's led to extensive changes in ecosystem structure in grasslands of the southwestern United States (Leopold 1924, West and Van Pelt 1987, Evans 1988), including Bandelier (Allen 1989). Current perspectives hold that herbaceous ground cover and litter were reduced, exposing increasing areas of bare soil that led to decreases in water infiltration and increases in surface runoff from the typically intense local summer rains. Reductions in grassy understories led to widespread establishment of piñon and juniper trees that now dominate low elevation woodlands.

Piñon-juniper woodlands that cover 40 percent of Bandelier display the disrupted native plant communities described above (Allen 1989). A soil survey of the affected piñon-juniper woodlands estimates soil erosion rates of 0.53 cm/year (0.2 in/year) or 79.3 megagrams/ha/year (35.7 tons/acre/year; Earth Environmental Consultants, Inc. 1978). Given total soil depths to bedrock ranging from 15 cm to 1 meter, the erosion rate of 53 cm per 100 years reflects unsustainable soil loss. The situation at Bandelier is made urgent by the presence of 3,000 to 4,000 archeological sites, mostly located in piñon-juniper woodland areas. An archeological survey found that over 75% of inventoried sites are being damaged by erosion (Orcutt 1990).

Considering the severe erosion problems that exist at Bandelier, there is concern that increased elk utilization of these areas will exacerbate these problems. Ongoing research into potential revegetation methods for bare soil areas, furthermore, suggests that the trampling by elk could be a significant impact leading to accelerated soil erosion (Sydoriak 1995, Snyderman and Jacobs unpublished data, Lithgow et al. unpublished data).

Deer within Bandelier may also be of management concern. A 1934 wildlife survey found deer to be scarce throughout Bandelier and the Jemez Mountains, although some tracks were seen (Borell 1934). This scarcity was attributed to hunting pressure. By 1940, W. McDougall (1940) noted that, "Mountain mahogany [*Cercocarpus montanus*] is quite abundant in places and most of it seems to have been very severely browsed". In 1945 the park custodian states "mule deer seem to be getting more numerous every year near Frijoles Canyon Headquarters and it may be not many years before we have a 'deer problem' (Thomas 1945). In 1960 J. Spillett emphasized that: "The greatest wildlife problem at present in Bandelier is that of too many deer. . . Almost the entire deer range in Bandelier is over-browsed and in poor condition" (Spillett 1960). While clearly imprecise, deer population estimates in annual wildlife reports on file at Bandelier show a perception of markedly increased deer numbers by the 1950's.

More recently, Potter and Berger (1977) reported heavy browsed mountain mahogany in some areas of Bandelier. Fieldwork in 1987 showed that mesa-tops in the Frijoles drainage continue to display extreme browsing of mountain mahogany and other species. Over 10 percent of the entire Frijoles watershed displayed "moderate" or "severe" browsing of shrubs (Allen 1989). Browsing by deer populations may be seriously inhibiting the reproduction of mountain mahogany and other plant species at many mesa-top sites.

Previous work outlined above suggest elk or deer reductions may be required to prevent resource damage. The aim of this project is to determine current impacts on vegetation and soil erosion rates by elk and deer and to determine sustainable ungulate population levels relative to the current populations.

Action Objectives

The proposed alternative will be implemented with the objective of answering the following questions.

- 1) What affects are current and projected populations of elk and deer having on aspen, willow, mountain mahogany and other plant species?
- 2) What affects are current and projected populations of elk and deer having on soil erosion rates?
- 3) Considering the impact to soil and vegetation, what are the ramifications for cultural resources?
- 4) What are defensible and feasible resource protection options based on results from this investigation?

Action Constraints

Selection of research methodologies, choice of study locations and design of the study, as presented in the proposed alternative, were influenced by the following constraints:

- 1) Designated wilderness area restrictions,
- 2) Sensitive species and sensitive habitat considerations,
- 3) Location and site density of pre-historic cultural resources,
- 4) Department of Interior (DOI), National Park Service (NPS) and Bandelier National Monument laws, regulations, policies and guidelines relevant to research and resource management activities
- 5) Applicability of project results to large areas of the Bandelier landscape, and
- 6) Logistical (i.e. access, timing, personnel, funding) considerations.

Legal Authority

Management of Bandelier National Monument is directed by public laws, rules and regulations, and directives of the Secretary of Interior, including the Wilderness Act, Endangered Species Act, and the National Park Service (NPS) Organic Act. Bandelier was established for the protection and preservation of archeological resources. Subsequent legislation has expanded the park's mission to include protection and preservation of both natural and cultural resources.

The establishing legislation of the National Park Service, known as the Organic Act, charges the Service to "promote and regulate the use of the Federal areas known as ... monuments ... to conserve the scenery and the natural and historic objects and the wildlife therein...in such manner and by such means as will leave them unimpaired for the enjoyment of future generations. 16 U.S.C. § 1 (1988)."

Court decisions have upheld NPS management authority over wildlife. The U.S. Supreme Court, in *Kleppe vs. New Mexico* 426 U.S. 529 (1976) upheld that the NPS Organic Act is a valid exercise of Congress' power under the Property Clause of the U.S. Constitution and in so doing stated that:

"... the complete power that Congress has over public lands necessarily includes the power to regulate and protect the wildlife living there."

A decision by the United States Tenth Circuit Court of Appeals in *New Mexico vs. Udall* 410 F.2d 1197 (10th cir.) 396 U.S. 961 (1969) found that:

"... The Secretary [of the Interior] has broad statutory authority to promote and regulate the national parks to conserve the scenery and wildlife therein "in such manner and by such means as will leave them unimpaired for the enjoyment of future generation." 16 U.S.C. 1. Anything detrimental to this purpose is detrimental to the park. In addition, the Secretary may make reasonable investigations ... to ascertain the number [of animals] which ... [an] area will support without detriment to the general use of the park.

The court further wrote:

[The Secretary] need not wait until the damage through overbrowsing has taken its toll on the park plant life ... before taking preventive action no less than he would be required to delay the destruction of a vicious animal until after an attack upon a person." 410 F.2d at 1201.

Threat to archeological resources and naturally functioning ecosystems through accelerated soil erosion, unstable plant communities, and unnatural vegetation change rank as the highest priorities in Bandelier's Resource Management Plan.

Gaining information for the protection of natural and cultural resources is authorized and supported by numerous laws, regulations, policies and guidelines pertaining to management of lands administered by the National Park Service. A listing of legal references relevant to the management of national park lands can be found in the Bandelier Resource Management Plan, Appendix F and in the Natural Resource Management Guidelines, NPS-77, Chapter 2 and Appendix A. Specifically, NPS natural resource management policy (NPS-77, 1991) dictates that lands and habitats be managed in a manner to "maintain, rehabilitate, and perpetuate their inherent integrity."

All projects proposed for Bandelier National Monument must gain initial concept approval from the management staff. Subsequently, proposed projects must consider natural and cultural resource protection needs through compliance with a variety of laws regulating how federal agencies manage natural and cultural resources under their administration. This environmental assessment is in partial fulfillment of requirements under the National Environment Policy Act. In addition, this project will be subject to cultural compliance under the National Historic Preservation Act and biological compliance under the Endangered Species Act. Finally, this project is subject to all guidelines and restrictions as set forth in the Bandelier National Monument, Guidelines for Scientific Research.

Decisions to be Made

This environmental assessment presents information necessary for the decision maker (Superintendent of Bandelier) to decide whether the proposed action, as described, should be implemented. The proposed action would have two components 1) establish sixteen 60-meter by 60-meter ungulate exclosures with fences approximately eight feet tall within Bandelier National Monument for the purpose of determining the impacts of elk and deer on park resources and 2) overstory reduction on 5 exclosures and reference areas to evaluate the impact of ungulates on piñon-juniper restoration efforts (overstory removal). Comparisons will be made between the exclosures and same-size unfenced reference areas. The area within the exclosures and reference area would be intensively sampled to record differences due to elk and deer. For a minimum of three years after the exclosures are established, both exclosures and reference areas will be intensively sampled to assess changes in herbaceous cover, soil seedbank, soil erosion, faunal populations, and condition of cultural resources. The proposed action would also require an exception to the Draft Bandelier Wilderness Stewardship Plan (Sydoriak 1995b) because of construction of metal structures (fences), helicopter use and placement of numerous metal stakes in the Bandelier Wilderness.

Description of Alternative Actions

This Environmental Assessment considers three alternatives in detail: no action (continuation of present management action/inaction); partial action (building 16 exclosures and 16 unfenced reference areas) without conducting an overstory removal for piñon-juniper sites); and the proposed action (building the 16 exclosures and 16 unfenced reference areas, and implementing an overstory removal for piñon-juniper sites). One alternative, considered and eliminated, proposed the action (exclosure construction and overstory removal) be implemented on adjacent federal land managed by the Santa Fe National Forest.

ALTERNATIVES CONSIDERED AND ELIMINATED

Locate project on adjacent national forest lands:

Under this alternative exclosures and reference areas would have been located on the Santa Fe National Forest instead of on Bandelier National Monument; implementation of the project would otherwise have been as described under the proposed alternative (alternative 3).

Suitable sites in similar habitat could be found on the Santa Fe National Forest, but given the different management objectives of national forest lands much less control could be maintained over the research sites. In addition, a significantly increased potential exists for introduction of uncontrolled experimental variables and loss or damage to exclosures, marking stakes, and equipment. For these reasons the work will be conducted within Bandelier National Monument.

Research results concerning elk and deer impacts will have the most relevance to park management and will best fulfill the desired objectives if the work is located within the monument. While general results of ungulate impacts may be broadly applicable, it is important to examine the impacts specifically within the park where future management action may ultimately be applied. In addition, the park can provide more secure and stable long-term study sites for this project minimizing a number of potential impacts (i.e. livestock grazing, fuel-wooding, vehicle impacts, vandalism to equipment, etc.) likely to occur on national forest lands which could complicate interpretation of experimental results.

NO ACTION (ALTERNATIVE 1)

Continue current management of ungulate populations:

Under the no action alternative, documentation of existing conditions and small scale elk-related studies will continue, but evaluation of park-wide elk impacts will not occur. Evaluation of the impacts of ungulates on overstory removal as a restoration treatment in piñon-juniper woodlands will also not occur.

The no action alternative will allow for existing small-scale elk and deer resource management activities. These activities include continued documentation and quantification of existing resource conditions, winter elk and deer aerial counts over the park, as well as completion of ongoing elk trampling experiments, exclosure studies within the piñon-juniper restoration sites, and exclosure studies near the Apache Spring Trail.

The park maintains a dispersed vegetation and soil monitoring network, in part sampling degraded piñon-juniper sites, which provides a baseline for assessing future changes due to elk and deer in lieu of active management. This monitoring system is modeled after the Long Term Ecological Research design developed by the University of New Mexico (Beeley 1996). The park also conducts extensive photo-documentation of baseline conditions in the piñon-juniper community. Baseline assessments of cultural resource condition are also in progress.

Under the no action alternative, no additional metal stakes and no additional fencing would be used. No construction of exclosures would occur in any areas of the Bandelier Wilderness. Helicopter use associated with the proposed action would not occur.

Partial Action without an overstory removal on piñon-juniper sites (ALTERNATIVE 2)

Evaluate ungulate impacts except in piñon-juniper restoration areas:

Fifteen potential study sites have been identified within Bandelier (Figures 1, 2, and 3). These sites were chosen at random so results can be applicable to the larger landscape of Bandelier. At each of the sites, two 60-meter by 60-meter areas will be identified, and separated by approximately 20 meters (Figure 4). For each site, an exclosure will be randomly

Figure 1: Locations for
Paired Exclosure and Reference Areas
in Pinyon-Juniper Habitats

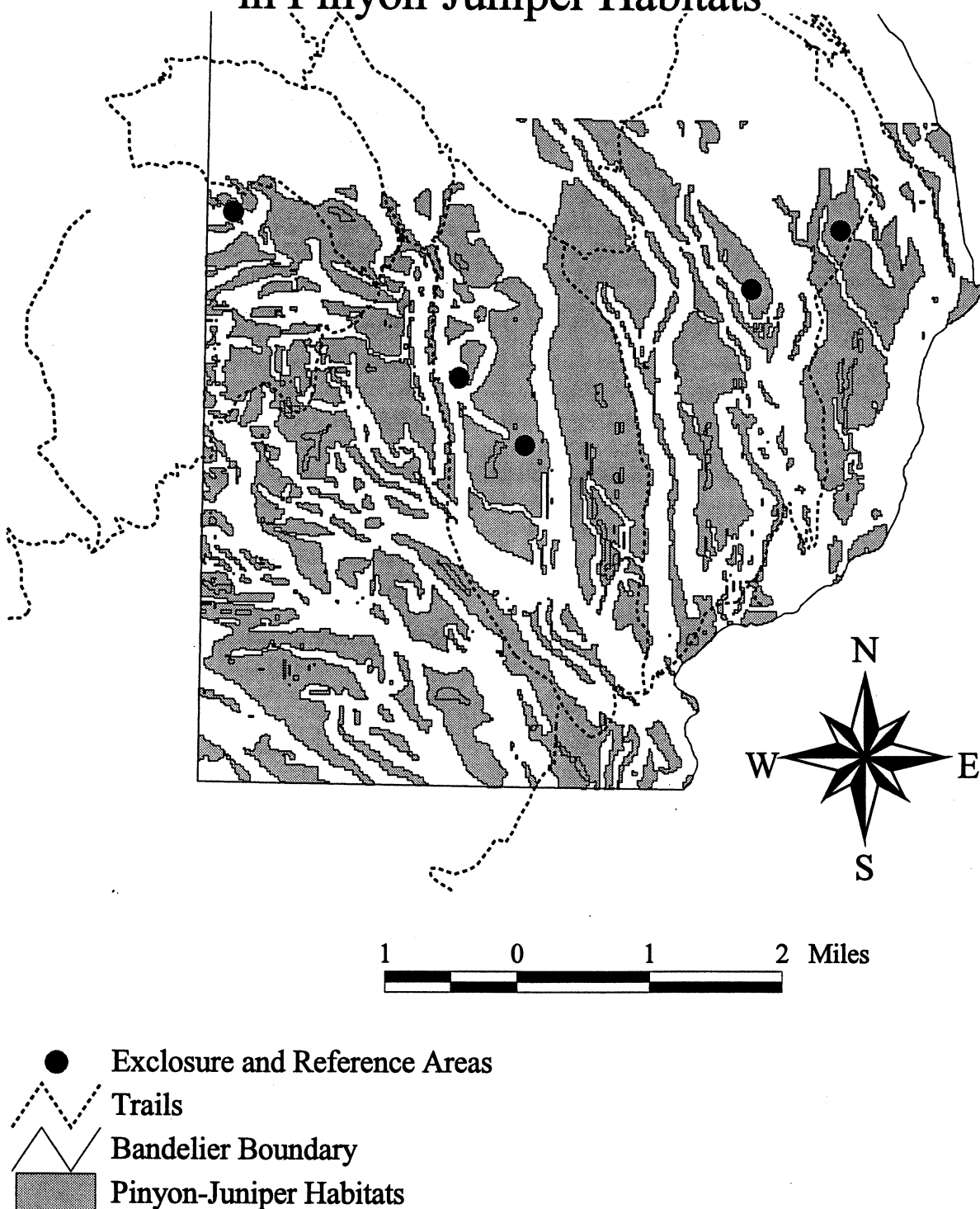


Figure 2: Locations for
Paired Exclosure and Reference Areas
in La Mesa Grassland
-Ponderosa Pine Habitats

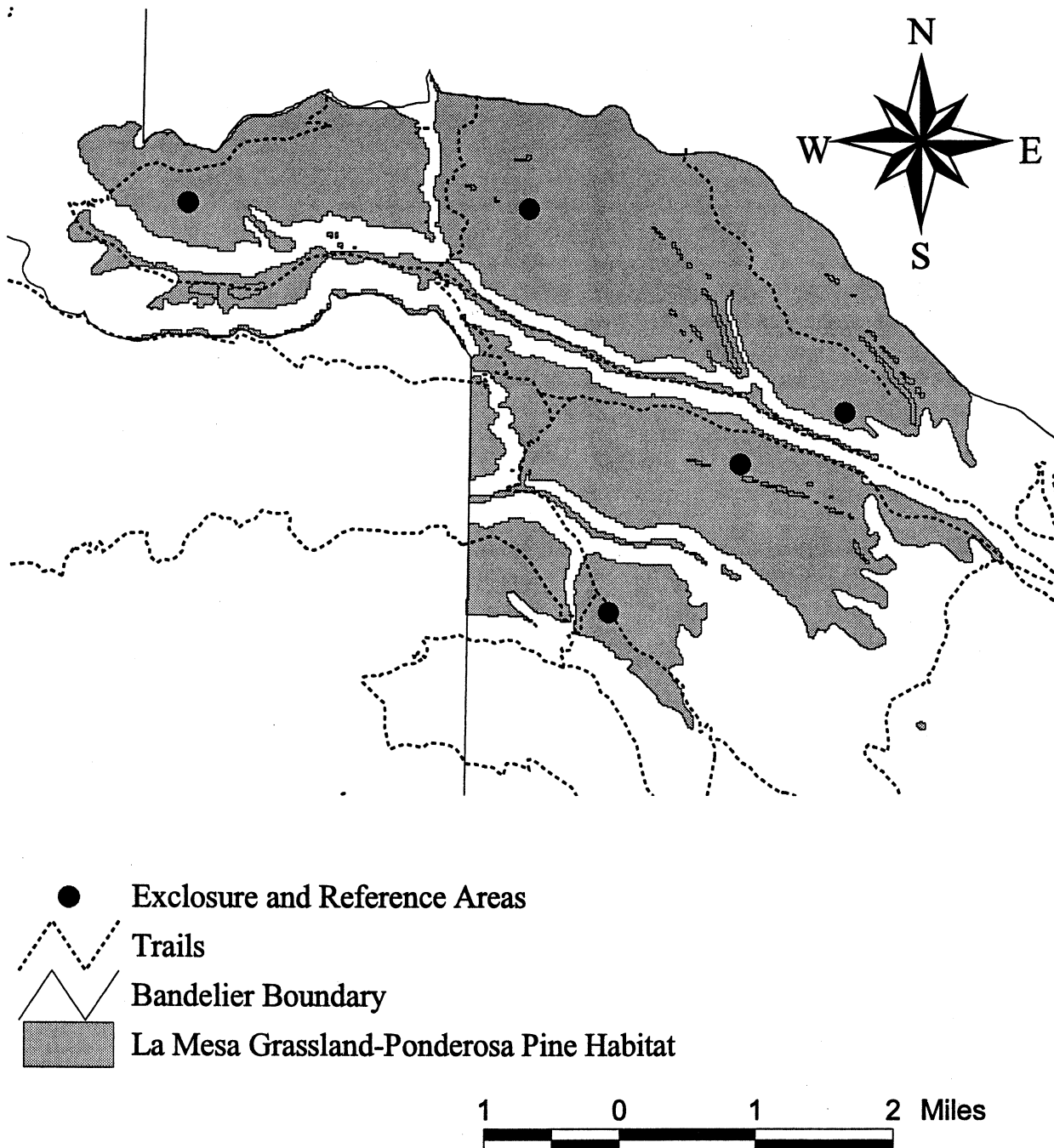


Figure 3: Locations for
Paired Exclosure and Reference Areas in
Mixed Conifer and Aspen Forest Types

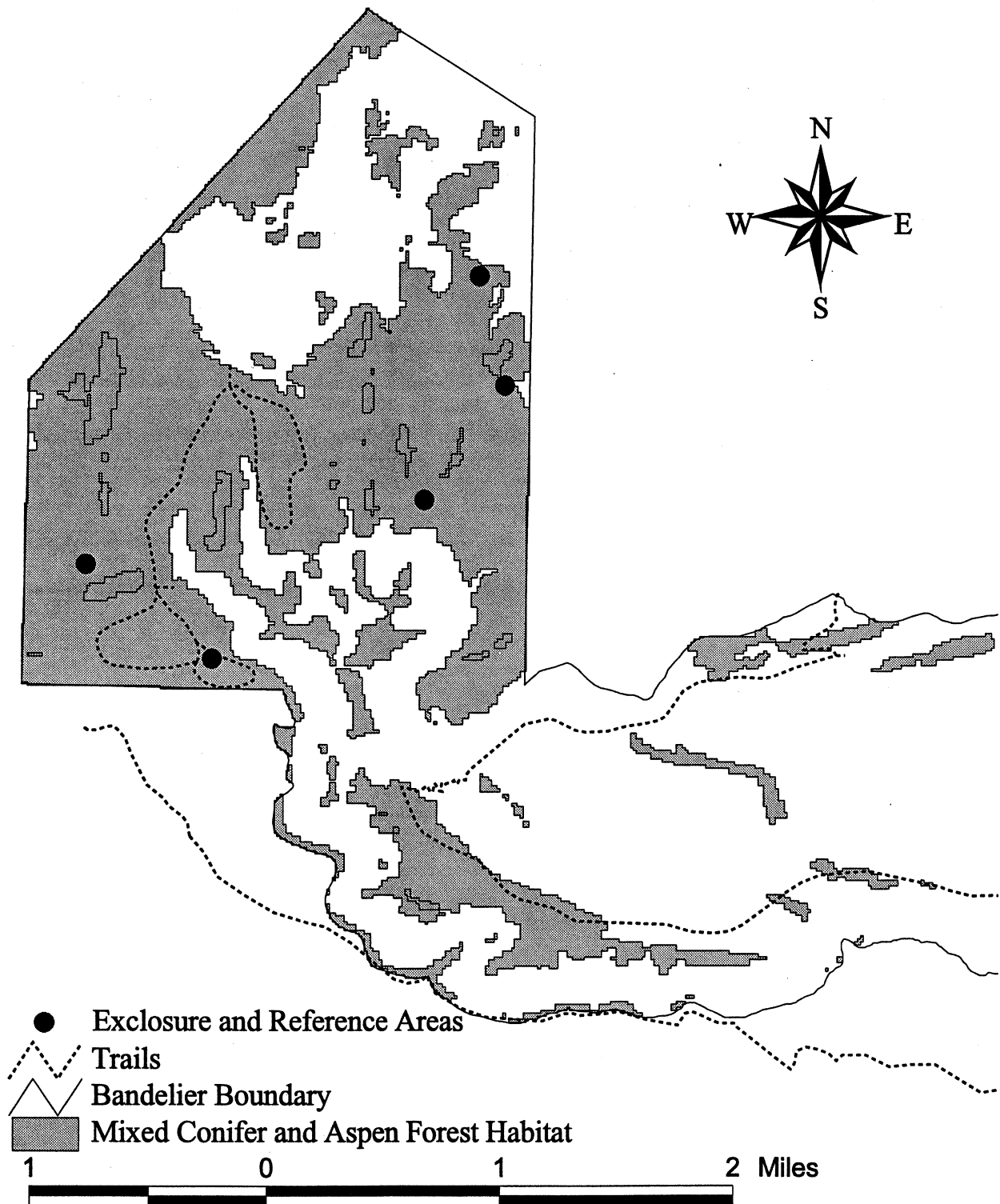


Figure 4: Below is an example of the layout for paired enclosure and unfenced reference areas. At each site, an enclosure will be randomly assigned to one of two 60-m x 60-m areas.

An unfenced reference area will be assigned to the other 60-m x 60-m area. At pinyon-juniper sites, overstory removal by chainsaw will take place within an 160-m x 80-m area.

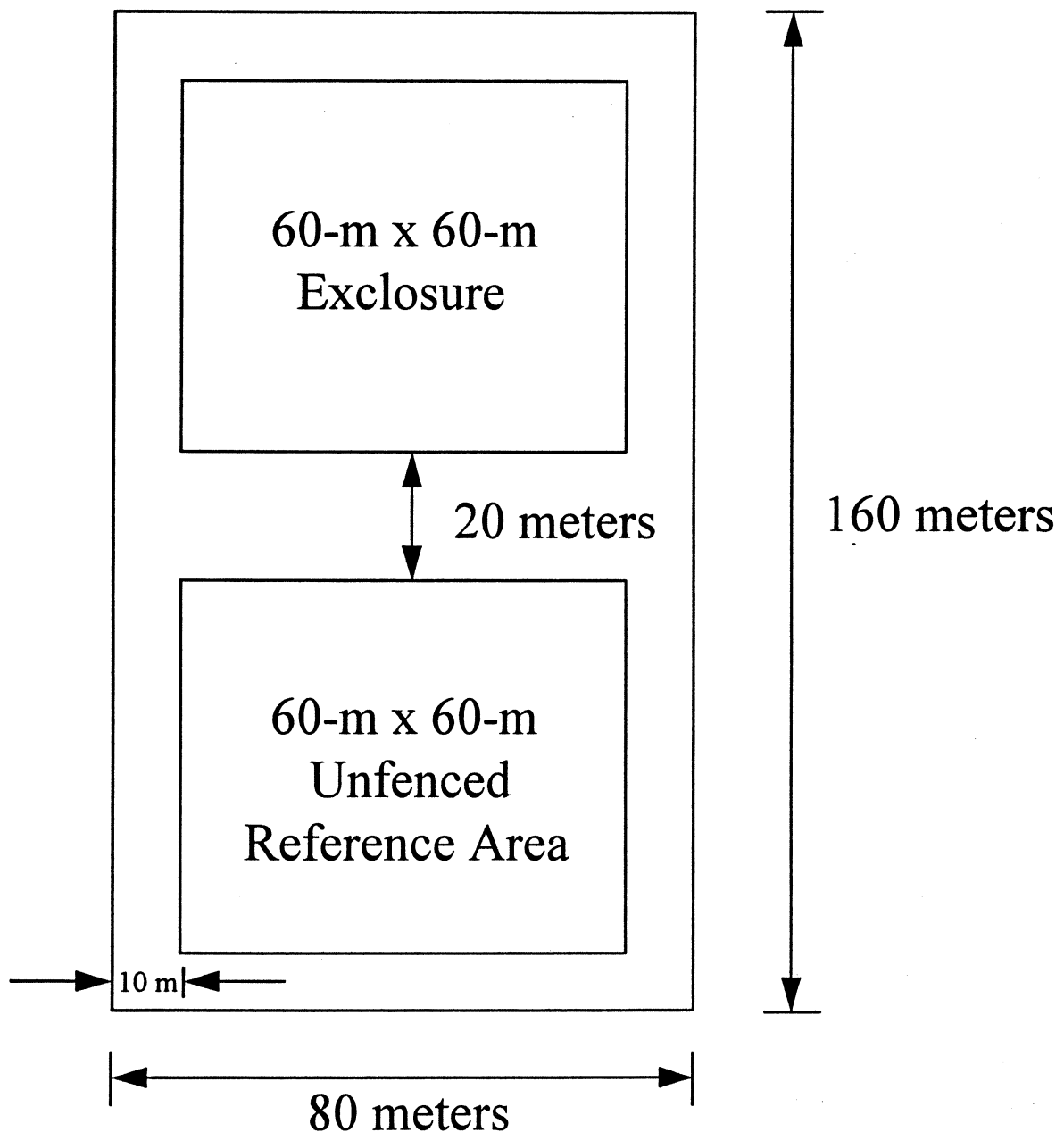
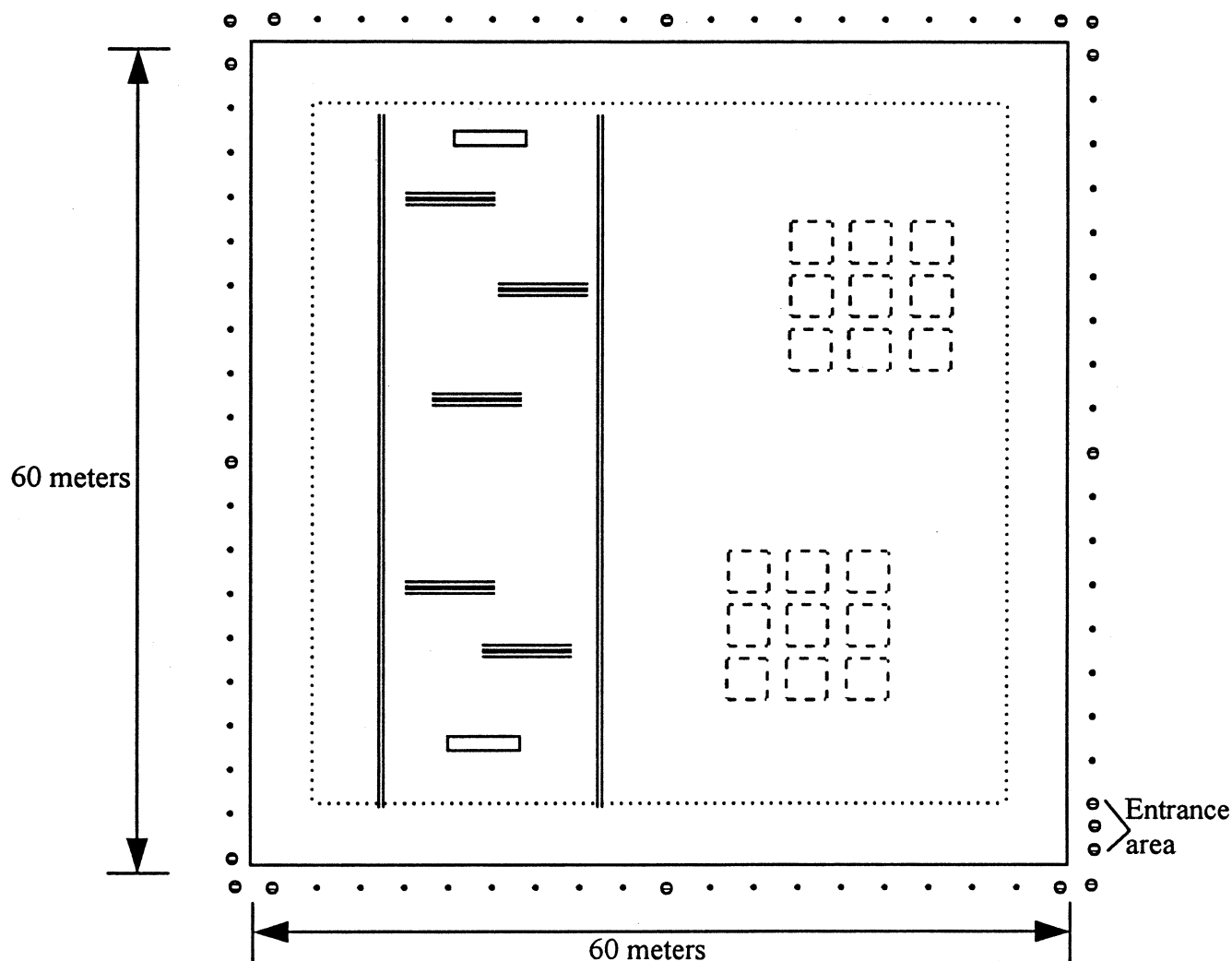


Figure 5: Below is an example of the layout for each enclosure.
The research design will be the same for each reference area, except no fencing will be used.



Core 50-m x 50-m research area within enclosures and reference areas; provides a 5-m buffer zone to minimize measurement of edge effects and human trampling.



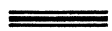
Two vegetation transects, 50-m randomly located in one half of the area; stakes every 10 m.



Arthropod pit traps, two per area.



Plots (1-m²) for simulated trampling and herbivory will be located in blocks of 9. Two blocks will be randomly located for a total of 18 plots. These plots will be used only in enclosures, not in reference areas, and will be located in the enclosure half not used by the vegetation transects.



Randomly located erosion bridges at pinyon-juniper sites; 5 per enclosure or reference area, each 1.5 meters long.

◉ Fence post, cemented.

• Fence post, no cement.

assigned to one area. The other area will become an unfenced reference area. Two additional area will be selected specifically for studying elk impacts to cultural resources. An enclosure will be randomly assigned to one area. The other area will become an unfenced reference area.

Ecosystem response to changes in herbivory and trampling will be assessed by documenting changes in herbaceous and woody plant cover, as well as changes in exposed soil cover. Additional responses will be assessed by recording site utilization by bird, small mammal, ground-dwelling arthropod, and lepidoptera populations.

The results will be generally applicable to the park as a whole, with specific information for piñon-juniper woodlands, La Mesa Fire grasslands, and mixed conifer forests. The results will be ecologically relevant and will provide an opportunity to assess future ungulate management options within the park.

Under the partial action alternative, 708 metal stakes (28 for each enclosure and ten for each reference area, with an additional ten stakes for erosion bridges at each enclosure and reference area in piñon-juniper habitats) will be used. The total linear length of 8-ft tall fencing will be 3840 meters (4160 yards; 240m (260 yards) for each enclosure). Holding the fence in place will be 1280 metal fence posts (80 for each enclosure). A total of 270 80-LB bags of cement will be use to secure some fence posts (18 bags for 18 posts at each enclosure).

Exclosures will be built in several areas of the Bandelier Wilderness. According to the Draft Bandelier Wilderness Stewardship Plan, six exclosures would be built in transition zones, two in semi-primitive zones, five in primitive zones, and three in semi-pristine zones. No exclosures will be built in front-country areas. A total of approximately 176 helicopter trips will be needed to move construction materials. Of these trips, approximately 44 will enter or cross semi-pristine zones, 99 will enter or cross primitive zones, 22 will enter or cross semi-primitive zones, and 55 will enter or cross transition zones. Approximately 121 helicopter trips will cross front-country areas. On Average, each trip will last approximately 15 minutes for a total of approximately 44 hours of helicopter flight time.

INFRASTRUCTURE DEVELOPMENT

Ungulate Exclosures:

Sixty-meter by 60-meter fenced, ungulate exclosures will be constructed at sixteen separate locations. Fifteen exclosures will be randomly located divided between three habitat types,

piñon-juniper (Figure 1), La Mesa Fire area (Figure 2), and mixed conifer and aspen forests (Figure 3). One additional exclosure and reference site will be established based on consultations with the park's Archeologist and the specific need to gain information on ungulate impacts to structural cultural sites. Similar sized unfenced areas will be associated with each exclosure (Figure 4).

Exclosure fences will be made of 11 gauge graduated field fence placed on 2-inch diameter galvanized steel posts. The field fence will run from the ground to approximately 8 feet above the ground. Each exclosure will have approximately 80 posts. Posts will be 12 feet tall, set at least 2.5 ft into the ground. Each post will be topped with a 45-degree end-cap for holding two strands of unbarbed wire above the field fence. Corner posts will be 2.5 to 3-inches in diameter drill casing pipe, 12 feet tall and set 2.5 ft into the ground. Corner posts and the posts adjacent to each corner will be cemented into the ground for stability. One post near the center of each side will also be cemented as will two additional posts for an entry way (Figure 5). For strength, 1.75-inch diameter diagonal braces will run from near the top of each corner post to near the ground on the adjacent posts. Materials (fence, posts, post caps, wire, cement and water) will be helicoptered into the sites. All extra materials will be removed after the exclosures are constructed.

Transect Stakes and Erosion Bridges:

Vegetation transect stakes utilize two-foot ($3/4"$ x $1/4"$) aluminum stock set approximately one-foot deep; the experimental design requires placement of approximately 28 stakes per exclosure or reference area. At piñon-juniper sites, erosion bridge stakes utilize two-foot ($3/4"$ diameter) rebar set approximately one foot deep; the experimental design requires placement of approximately 10 rebar stakes per site. Soil moisture probes (15" long) may be installed in the ground (approximately 15 inches deep) at up to 20 locations at piñon-juniper sites.

DATA COLLECTION

Biomass Measurements

Each fall, grass and herbaceous cover will be clipped from a marked set of randomly located quadrats at each site, dried, and weighed to determine available biomass. Another set of randomly located quadrats will be sampled in the spring before the growing season to evaluate winter biomass removal. Each quadrat will be a 0.5-m^2 sample, with plants identified to species when possible. For grasses sampled during the fall, vegetative parts will be measured separately from the seed-bearing parts as an index of plant vigor. The number of quadrats will be determined by an

analysis of statistical power using previously collected biomass data from Bandelier (Wolters 1996, Wolters unpublished data).

Soil Surface Cover

Changes in soil surface cover will be measured at all sites with two 50-m vegetation line transects using a modified University of New Mexico Long Term Ecological Research (LTER) program design. Transects will be placed randomly within exclosures and reference areas. The LTER design records vegetation cover at 1-cm intervals. The design records vegetation cover at both the ground level and at several heights above the ground. Transects will be oriented parallel to the most prominent topographic contour at each site to minimize variations due to placement along a slope. Each transect will be marked with aluminum stakes at 10-meter intervals. Transect data will be collected each fall after the growing season and before snowfall, and each spring as soon after snow melt as possible.

Tree and Shrub Mapping

Trees larger than 2 cm DBH at all sites will be mapped and marked using two- to three-inch metal tags nailed into a trunk about 5 feet above the ground. Estimate height, diameter at breast height (DBH), and crown cover will be recorded. Trees will also be visually rated based on intensity of ungulate damage. Shrubs will be hand measured, and mapped with height and crown cover area recorded.

Arthropod Pitfall Traps

Arthropods will be destructively sampled using pit traps with non-toxic propylene-glycol as a collection trap medium. Installation of arthropod pitfall traps, at two locations within each exclosure and each reference area, will necessitate excavation of a small pit (i.e. 6 inches deep x 3 inches wide) at each sample point.

Lepidoptera (butterfly and moth) Collection

Butterfly and moth larvae will be collected from approximately 10 random locations within each exclosure and reference area. Each sample location will be vertical cylinder one-square-meter extending from ground to the top of reachable plant growth. Lepidoptera will be dislodged from foliage by shaking stems and branches of plants. The larvae will be reared to adults for identification, then fumigated for permanent museum storage. Collections will be managed according to NPS protocols and will remain NPS property even when curated by a non-government museum or university.

Bird Nest Searches

Exhaustive searches for bird nests will be conducted at all exclosures and reference areas. Nest searches will be conducted each spring for the duration of the project from approximately May 1 through July 15. Pending approval by the U.S. Fish and Wildlife Service and the New Mexico Department of Game and Fish, young of the most common species will be banded.

Small Mammal Catch-and-Release Trapping

Small mammal populations will be measured using catch-and-release trapping within exclosure and reference areas. Approximately three to four nights of trapping will be conducted per area. So as to minimize any potential trapping mortality, traps will be continuously monitored throughout the night and trapping will be confined to July and August, when night time temperatures are highest. Researchers will take appropriate precautions to avoid Hantavirus and other health hazards.

Ungulate Pellet-group Counts

Elk and deer usage will be measured through pellet-group counts on the monitoring sites and with pellet-group counts on an equal area around each exclosure.

Erosion Monitoring

At piñon-juniper sites, erosion bridges will be established. Bridges will be randomly located between LTER transects. Bridges will be 1-m long and oriented along a contour. Two firmly set, leveled, metal rods mark the ends of each bridge. A 1.5-meter metal bridge will not remain on site, but will be brought to the sites only for recording data. The metal bridge is placed onto the metal marking rods and thirty points are measured by inserting a metal pin down (through pre-drilled holes) to the ground or litter. The bridge to ground or litter distance and ground cover type are recorded. Measurements on the bridges will be collected each spring (after snow melt and before the summer rains) and fall (after the summer rains and before snowfall). Approximately 5 bridges will be established in each exclosure and reference area.

Soil Seed Bank

In the first and last years (1997 and 2000) of the project, soil samples for seed bank analysis will be taken at four random locations within each exclosure and reference area at piñon-juniper sites. Samples will be germinated under optimal greenhouse conditions to assess changes and differences in density and diversity of the soil seed bank. An in-park greenhouse has been funded and is being constructed during the summer of 1997, subject to an earlier Environmental Assessment (Jacobs 1996).

Archeological Evaluations

Since an objective of this project is to determine ungulate impacts to cultural resources, archeological sites will be included in the random placement of exclosures and reference areas. All cultural sites selected will receive qualitative evaluations of the degree of current erosion, surrounding hydrologic conditions, integrity and alignment of building materials, signs of physical disturbance, and other standard archeological perimeters.

In addition to quantitative assessments of selected cultural resources, all cultural resources within the project areas will be qualitatively documented, a modified Monitoring data collection form. This form is in the process of being developed.

Visual documentation

Photographs and videos will be taken every spring and fall looking into each exclosure from all four corners and from all four sides. Vegetation monitoring sites will be photographed in a similar pattern. Special marking stakes are not planned for photopoints and videopoints since they will be in close proximity to the marked monitoring sites and exclosures.

SCHEDULE:

YEAR 1 (1997):

- 1) construct exclosures and mark reference areas,
- 2) collect baseline data, and
- 3) summarize baseline data.

YEAR 2 (1998):

- 1) collect year 1 post-establishment data,
- 2) summarize additional data, and
- 3) conduct a preliminary analysis.

Year 3 (1999):

- 1) collect year 2 post-establishment data,
- 2) summarize additional data, and
- 3) conduct a preliminary analysis.

YEAR 4 (2000):

- 1) collect year 3 post-establishment data,
- 2) summarize additional data,
- 2) conduct final data analysis, and
- 3) draft final report.

PROPOSED ACTION (ALTERNATIVE 3)

Evaluate ungulate impacts on vegetation within mixed conifer-aspen forests, La Mesa Fire grasslands, and piñon-juniper woodlands including piñon-juniper overstory treatment areas.

The proposed action will implement Alternative 2 plus implement and evaluate vegetation recovery after the overstory has been largely removed at piñon-juniper sites (Figure 1). The current degraded condition of many piñon-juniper areas is so severe that little vegetation is available to show elk impacts. Conducting an overstory removal has been shown to promote vegetation recovery. Thus, conducting an overstory removal in piñon-juniper sites will create conditions where elk impacts will be measurable.

In addition, it is critical to assess overstory removal so as to evaluate the impact of ungulate herbivory on piñon-juniper restoration. A detailed study plan, Watershed Restoration in Degraded Piñon-juniper Woodlands (Jacobs et al, 1996), documents experimental design, sampling methodology, experimental timetable, and statistical considerations for overstory removal within a single watershed, currently being implemented. This piñon-juniper watershed restoration project was submitted for public comments in 1996. Results from study of one watershed will not be clearly applicable to other piñon-juniper woodlands of Bandelier. Such applicability is needed if restoration efforts are to be considered for other places at Bandelier. Examining five sites of piñon-juniper restoration will give results applicable to many areas of Bandelier.

The effects of overstory removal on many ecological processes (i.e. runoff, sediment transport, grazing pressures, etc.) will be evaluated by documenting soil erosion rates and changes in the soil seedbank at piñon-juniper sites.

The number of metal stakes, the length of fence, and number of fence posts, amount of ground disturbance, and duration and distribution of disturbance within wilderness zones will include those listed under Alternative 2. This alternative will cause approximately one month additional disturbance through the use of chainsaws within the Bandelier Wilderness at the five piñon-juniper sites (Figure 1).

OVERSTORY REMOVAL / SLASH MULCH

(Piñon-Juniper habitat only)

The overstory removal component will reduce tree cover at the five piñon-juniper sites by a minimum of 75% through removal of the smaller age-class trees (i.e. those less than six to eight

inches in diameter at breast height (DBH)). Overstory removal will be accomplished using chainsaws operated by a four- to six-person crew.

Individual trees to be saved will be flagged; all others will be cut flush to the ground. Branches will be lopped off the main trunks and distributed uniformly across the site. Larger trunk sections will be laid perpendicular to the slope to slow sheet runoff and interrupt micro-drainage patterns.

The overstory removal treatment will be accomplished in approximately a one month period, between September 1 and November 1, over all five of the piñon-juniper sites.

Affected Environment

Bandelier is located on the southern portion of the Pajarito Plateau in the Jemez Mountains at the southern edge of the Rocky Mountains in north central New Mexico. The area is composed of volcanic ash and lava flows that have been eroded into deep canyons. The park comprises 13,250 hectares (32,727 ac) and extends from the Rio Grande at 1,680 meters (5,300 ft) to the summit of Cerro Grande at 3,240 meters (10,200 ft) on the Jemez Caldera rim. The park's landforms and vegetation have been subjected to a variety of significant human influences, particularly grazing and fire suppression (Allen 1989).

Located on the eastern slopes of the Jemez Mountains, most of the park is on the Pajarito Plateau. The plateau slopes toward the Rio Grande and five canyons dissect the plateau in a northwest to southeast alignment. The five canyons support base flows originated from springs and seeps along the mountain / plateau interface.

The climate is semi-arid, the area receiving an average precipitation total of about 16 inches per year with 70% of the moisture occurring during the monsoons which typically arrive in July and run through August. The average temperature ranges from 29° to 82°F (Allen 1989).

The significance of Bandelier lies in its superb combination of cultural, natural, and wilderness values. To recognize the wilderness values, President Ford signed legislation in October, 1976, creating a 9,423 hectares (23,267 ac) Bandelier Wilderness (P.L. 94-567). Ninety percent of the park is managed as

backcountry / wilderness and more than half of its trails (Frijoles Canyon and Bandelier Backcountry) are part of the National Trail System.

Native Americans are believed to have lived in the region for the past 10,000 years. However, the ruins noted in the enabling legislation were occupied by the Ancestral Puebloans between 1100 and 1600 AD. The full extent of archeological resources is unknown. However, the Bandelier Archeological Survey of 1987-91 surveyed 43 percent of the park, recording over 1500 sites with an overall site density of one site per 2.7 hectares (6.8 ac).

Nearly one-third of Bandelier National Monument is piñon-juniper woodland (dominated by *Pinus edulis* and *Juniperus monosperma*). Approximately sixty percent of the known Ancestral Puebloan prehistoric sites surveyed at Bandelier occur in piñon-juniper woodlands. More than seventy-five percent of 1,500 Ancestral Puebloan sites, recently surveyed for erosional damage at Bandelier, have significant impacts. Piñon-juniper woodlands have been harvested since prehistoric times for fuel-wood. In the last 150 years these areas have also been utilized for livestock grazing. Across most of Bandelier, fuel-wood harvesting has not been a factor in historic times, but intensive livestock grazing was pervasive until around 1940. Until the early-1980's a sizable feral burro population also roamed the southern portion of the park.

Piñon-juniper woodlands near park headquarters at Bandelier exhibit tree canopy coverages of 25 to 60%, herbaceous overstory coverages of 8 to 15% and exposed soil coverages of between 35 and 55%. Soil loss has been estimated at nearly one inch per decade; an unsustainable rate given shallow soil depths of one to three feet. Intensive characterization of erosional processes on a one hectare piñon-juniper hillslope at Bandelier suggest soil losses of 25,000-50,000 kg over a two year period, most of it occurring during a few intense summer rain events during year 1 of the study (Wilcox et al., in press).

Major Issues

ISSUES CONSIDERED FOR AFFECTS FROM ALTERNATIVE ACTIONS

CRITICAL ELEMENTS	AFFECTED	
	Yes	No
Air Quality		X
American Indian Religious Uses	X	
Cultural / Historical Resources	X	
Farmlands, Prime / Unique lands		X
Floodplains	X	
Hazardous Materials		X
Health and Safety	X	
T&E Species	X	
Vegetation and Soils	X	
Visitor Use / Education	X	
Water Quality	X	
Wetlands / Riparian Zones	X	
Wilderness / Scenic Values	X	
Wildlife	X	
Other Connected Actions	X	

Environmental Consequences SUMMARY OF POTENTIAL ENVIRONMENTAL EFFECTS

AMERICAN INDIAN RELIGIOUS USES

NO ACTION (ALTERNATIVE 1)

No change in native American religious uses is anticipated.

PARTIAL ACTION (ALTERNATIVE 2)

Probably no restriction in native American religious use will occur. Adverse effect to indigenous religious uses are possible during helicopter operations, construction, and data collection periods. It is also possible that a study site may be planned for a sacred site that we are not aware of. Mitigation measures or new study sites will be selected if potential conflicts are made known to Bandelier by Native American groups.

PROPOSED ACTION (ALTERNATIVE 3)

Same as for Alternative 2, with a slightly higher impact risk from the addition of overstory removal to five piñon-juniper sites.

CULTURAL RESOURCES

NO ACTION (ALTERNATIVE 1)

At piñon-juniper sites, there will probably be incremental loss of cultural materials over the short-term (10-20 years) and ultimate loss of entire sites including structures over the long-term (100-200 years). At La Mesa burn sites and mixed conifer and aspen sites, both short-term and long-term losses of cultural materials may be small or unmeasurable because soil erosion rates are low and vegetation growth is vigorous enough to maintain soil stability.

PARTIAL ACTION (ALTERNATIVE 2)

Based on animal bones recovered from archeological sites in and near Bandelier, there were relatively few elk in the Jemez Mountains prior to 1900, compared to present elk populations. Creating locally low elk density through the use of exclosures should reproduce the pre-1900 conditions for study of changes to vegetation and cultural resources. Enhanced stability of cultural resources within exclosures will likely occur due to anticipated increases in forest and grassland plant cover.

Consultation with the park archeologist, park Native American liaison, and the State Historic Preservation Office (SHPO) will be conducted if a review of the proposed project by the park archeologist suggests any likelihood of adverse effects on cultural resources. At a minimum, the SHPO will be notified of the proposed project and asked if they desire additional information or consultation. Physical, visual, and philosophical aspects of the project could degrade some cultural resource sites or traditional cultural properties.

All areas that will be exposed to ground disturbing activities will be surveyed before any work begins. All known cultural sites will be located, geo-referenced and minimally flagged prior to establishment of exclosure sites and reference areas, as well as all transects and sampling points to ensure sample points are not inadvertently set up on top of cultural sites. Cultural sites will be minimally flagged, to reduce highlighting these sensitive resources, by using only a single piece of flagging attached to each site stake; all flagging will be removed promptly following the first year's data collection. Areas suspected of having cultural significance will not be specifically avoided for the purpose of establishing vegetation transect locations and erosion bridges, since research results must be applicable to cultural sites, as well as to the general park landscape. The park archeologist will be consulted before any ground-disturbing activities occur near areas suspected of

having cultural resources. In fact, all work will be done in consultation with the park archeologist who will be contacted in the event established protocols for mitigation of cultural resource impacts are either unclear or inadequate.

The placement of aluminum stakes to mark transects in vicinity of cultural sites will be located so that the end points are off the structural portion of the site and near the margin of any observed surface artifact scatter. In general, it's important to link ungulate effects to cultural areas, as well as to effects over the general park landscape. Thus, cultural areas will not be specifically avoided.

In the La Mesa Fire grassland areas the exclosures may be visible for several hundred yards. In mixed conifer forests the exclosures may be well screened, but visible from across meadows and forest openings.

PROPOSED ACTION (ALTERNATIVE 3)

Same as for Alternative 2 and the overstory removal will likely mitigate erosional processes at piñon-juniper study sites. The appearance and function of piñon-juniper communities today is likely very different than in the last 1000 years. Significant numbers of trees have established in the last 150 years, transforming a fire dependent savanna system into a woodland. Prior to, and during, occupation of pre-historic cultural sites, it is thought that the piñon-juniper community was a savanna system with fewer, larger and more widely spaced trees. A natural fire regime prior to occupation as well as fire-ignition and fuel-wooding by pre-historic peoples, likely maintained this savanna system.

The current accelerated levels of erosion in degraded piñon-juniper communities are unprecedented in historic times. Successful restoration efforts will help to stabilize this landscape by mitigating catastrophic erosional processes. Normal erosional and weathering processes will continue to be a part of the restored system in which cultural sites are embedded.

Overstory removal at piñon-juniper sites using chainsaws could inadvertently damage prehistoric structural sites, if removal of trees on sites is not implemented carefully. To ensure that overstory removal does not impact cultural sites, the park archeologist or designated representative will be present during removal of the vegetation canopy at archeological sites. No rocks will be moved in the process of cutting trees, all cuts will be made well above and away from structural rocks. Felled trees and logs will not be dragged across sites. Trunk sections

will be carried off of structural sites to minimize heavy fuel loading on those sites.

Overstory removal at piñon-juniper sites may make some structural sites more visible to the visiting public; this removal will also change the general look of the landscape in which the sites are located. The current look of the Bandelier landscape, however, has been influenced by historic landuse practices resulting in significant tree invasion during the last 150 years. For the overstory removal in piñon-juniper areas, it is expected the restored cultural landscape will be more pleasing visually than the existing degraded landscape, based on observations of other restored sites.

FLOODPLAINS

NO ACTION (ALTERNATIVE 1)

Lack of information on the landscape-wide impacts of ungulates will prevent management actions that could decrease erosion rates. Within piñon-juniper habitats, inputs of soil and sediment will continue depositing into the Rio Grande / Cochiti reservoir.

PARTIAL ACTION (ALTERNATIVE 2)

In the La Mesa grasslands and mixed conifer forest, no change is likely.

PROPOSED ACTION (ALTERNATIVE 3)

Same as Alternative 2 and at piñon-juniper sites, overstory removal and subsequent increase in ground cover, could reduce the amount of sediment input to Cochiti Reservoir, but is unlikely to influence delta formation at the head of the permanent floodpool, since sediment sources exist all along the Rio Grande up stream from Bandelier. Any changes in sediment contribution from this study to the reservoir system are likely insignificant relative to total sediment input.

HEALTH AND SAFETY

NO ACTION (ALTERNATIVE 1)

As piñon-juniper habitats continue to lose soil, low infiltration rates and increasing expanses of bedrock could intensify flash flood events, increasing public risk.

PARTIAL ACTION (ALTERNATIVE 2)

Environmental consequences are the same as under Alternative 1.

PROPOSED ACTION (ALTERNATIVE 3)

At piñon-juniper sites, overstory removal will improve upper watershed conditions by allowing more rain water to be captured on site, thus, moderating runoff to downstream areas and reducing potential flood hazard risks to backcountry users.

T&E SPECIES

NO ACTION (ALTERNATIVE 1)

Slow degradation of the ecosystem through loss of soil in piñon-juniper habitats will continue. Potential losses in biological diversity and forest structural complexity will likely result in reduced prey bases for species of concern.

PARTIAL ACTION (ALTERNATIVE 2)

Likely enhancement of prey base for listed species except in piñon-juniper areas where no improvement is likely without overstory removal. Noise degradation of T&E habitat is anticipated from exclosure construction and helicopter operations, but all work will be applied outside of sensitive time frames. Thus, there should be no affect on T&E species.

Informal consultation (and preparation of a biological assessment), between the park and the U.S. Fish and Wildlife Service, may be necessary if helicopter flights are conducted during sensitive time of the year (March 1st through October 15th depending on location) and in sensitive locations. Any helicopter operations between October 15th and March 1st will have 'no affect' and consultation will not be required.

PROPOSED ACTION (ALTERNATIVE 3)

Same as Alternative 2 and the overstory removal at piñon-juniper study sites will likely have a minor beneficial affect on the prey base for listed species due to changes in prey species composition as vegetation changes within exclosures.

All chainsaw work will be applied outside of sensitive locations and time frames. Thus, there should be no affect on T&E species. Informal consultation (and preparation of a biological assessment), between the park and the U.S. Fish and Wildlife Service, may be necessary if chainsaw work is conducted between March 1st and October 15th depending on location. Overstory removal applied between October 15th and March 1st will have 'no affect' and consultation will not be required.

VEGETATION AND SOILS

NO ACTION (ALTERNATIVE 1)

Degradation of the plant and soil resources will continue. Undocumented change in wildlife species due to elk herbivory will continue.

PARTIAL ACTION (ALTERNATIVE 2)

No additional stabilization of eroding soils in piñon-juniper areas will occur. Soil moistures will continue to be low, thus, inhibiting recovery of the herbaceous plants at piñon-juniper sites.

At all sites vegetation will be trampled and cut along perimeter of each exclosure. In areas of thicker vegetation this would be similar to putting a narrow (2-5 feet) trail through the habitat. Cementing of corner and other posts of the exclosures will prevent plants from growing back near some posts and may have a small localized effect on soil chemistry.

PROPOSED ACTION (ALTERNATIVE 3)

Eroding soil will become more stable at piñon-juniper study sites. Soil moisture will increase, thus, promoting the recovery of herbaceous plants within exclosures. Woody overstory coverage will decrease.

The proposed overstory removal at piñon-juniper sites will modify the plant community in a manner similar to the application of prescribed fire. Mechanical removal of the woody overstory (i.e. restoration) is comparable to the stand-thinning effects of fire; both make limited water and nutrient resources more available to the herbaceous (grass and forb) plants. Results from ongoing studies at Bandelier document a seven-fold increase in herbaceous cover after two growing seasons post-treatment (Jacobs unpublished data). Previous soil moisture measurements show a twenty percent increase in volumetric soil moisture between treatment and control areas, suggesting treated areas capture and retain more precipitation than untreated areas. These data suggest that woody overstory removal can reduce competition for limited water and nutrient resources. In addition, slash mulch can provide a much needed protective layer over exposed soils which reduces runoff, sediment transport, and siltation while increasing infiltration, moderating soil temperature and soil moisture, redistributing soil nutrients, and providing some protection from grazing. Combined, these treatment effects can create favorable microsites for herbaceous plant establishment and growth.

VISITOR USE / EDUCATION

NO ACTION (ALTERNATIVE 1)

No changes in visitor use will occur. The park will lose, however, the opportunity to provide visitors with factual information on ungulate impacts on the Bandelier landscape and how that information could be used in management decisions.

PARTIAL ACTION (ALTERNATIVE 2)

Normal visitor use near the study areas will not likely be affected by project activities, since most work will be away from maintained trails. Visitors will be asked, however, not to enter exclosures and reference areas through the use of signs placed on the exclosures.

Noise from transport of materials by helicopter, chainsaws, gas-powered augers, handtools, and workers probably will have an adverse affect on visitor experience during exclosure construction.

The park will lose the opportunity to inform the public on the landscape-extent success rate of the overstory removal treatment for restoration of degrading piñon-juniper habitats.

Negative impacts to visitor experience during exclosures construction and transport of materials by helicopter (addressed more fully under *WILDERNESS / SCENIC VALUE* on page 32).

PROPOSED ACTION (ALTERNATIVE 3)

Visitors may have negative experiences due to noise near piñon-juniper sites during the implementation of overstory removal. The slash and stumps resulting from overstory removal could be viewed as a serious aesthetic impact by some visitors, as could the presence of exclosure fences (addressed more fully under *WILDERNESS / SCENIC VALUE* on page 32).

Evaluating a restoration technique such as overstory removal at the landscape level is necessary to properly evaluate the feasibility for large scale recovery of degraded piñon-juniper woodland systems. From an interpretive viewpoint, the piñon-juniper overstory removal part of this project will enable the park to evaluate the potential for restoration of degraded lands over larger areas than a single watershed or small plots. Since overstory removal in a wilderness setting may be misconstrued, it is important for park visitors to understand the necessity for stabilizing Bandelier's degraded piñon-juniper woodlands in order to protect threatened cultural resources. A self-guiding interpretative guide will be developed to educate visitors to the

ungulate exclosures with applicability to all the exclosure sites.

WATER QUALITY

NO ACTION (ALTERNATIVE 1)

Sedimentation from accelerated erosion will continue to degrade water quality.

PARTIAL ACTION (ALTERNATIVE 2)

Near all exclosures except those in piñon-juniper areas, water quality will improve because surface runoff will be moderated by an increase in plant cover, likely reducing the suspended sediment load. Increased infiltration of rainwater will provide opportunities for water to be cleaned while slowly percolating through soil and rock layers.

PROPOSED ACTION (ALTERNATIVE 3)

Same as for Alternative 2 and near piñon-juniper areas, water quality will improve because surface runoff will be moderated by an increase in plant cover, likely reducing the suspended sediment load.

WETLANDS / RIPARIAN ZONES

NO ACTION (ALTERNATIVE 1)

Down slope from piñon-juniper sites, significant inputs of suspended and bed sediments could continue to negatively impact the riparian systems. Upland range and forest changes due to ungulate herbivory could lead to drier conditions in some riparian areas.

PARTIAL ACTION (ALTERNATIVE 2)

Near piñon-juniper sites, riparian systems could continue to be negatively impacted by significant inputs of suspended and bed sediments into the riparian systems. Upland range and forest changes in exclosures could lead to wetter conditions in some riparian areas.

PROPOSED ACTION (ALTERNATIVE 3)

Near piñon-juniper sites, overstory removal and mulching should slightly enhance riparian conditions by increasing infiltration and soil water storage while simultaneously reducing the magnitude of silt laden runoff into down canyon and riparian areas. Changes in infiltration and soil water storage should be less pronounced near the La Mesa grasslands and mixed conifer

habitats, since these area are well vegetated and do not suffer from high erosion rates.

WILDERNESS / SCENIC VALUE

NO ACTION (ALTERNATIVE 1)

At piñon-juniper sites, accelerated erosional processes would ultimately convert much of the monument into bedrock badlands.

PARTIAL ACTION (ALTERNATIVE 2)

Some may feel that any intervention in a wilderness setting is unwarranted, since these areas were presumably set aside for minimal human intervention. Without information on park-wide ungulate impacts, current ungulate populations, specifically from elk, could degrade the structure and function of the Bandelier Wilderness.

The proposed action is currently being evaluated in terms of Bandelier's Draft Wilderness Stewardship Plan (Sydoriak 1995). Some study sites may be relocate due to restrictions on management structures and activities in the Bandelier Wilderness. Areas where exclosures are ultimately prohibited may be areas where the impacts of elk and deer remain unknown. These unknowns may limit future management options and actions. In any case, the proposed action will adversely affect wilderness values in the Bandelier Wilderness over the short term. Ultimately, restored ecosystem health should enhance wilderness values.

Construction of 16 60-meter by 60-meter, eight to ten-foot high ungulate exclosures will impose large human structures in designated wilderness. Exclosures would be built in several areas of the Bandelier Wilderness. According to the Draft Bandelier Wilderness Stewardship Plan, six exclosures would be built in transition zones, two in semi-primitive zones, five in primitive zones, and three in semi-pristine zones. No exclosures will be built in front-country areas. Exclosure fences at all sites will degrade scenic values.

Metal structures, stakes, posts, and cement in Wilderness may constitute long-term intrusions. Under the partial action alternative, 708 metal stakes (28 for each exclosure and 10 for each reference area, with an additional 10 stakes for erosion bridges at each exclosure and reference area in piñon-juniper habitats) will be used. The total linear length of 8-ft tall fencing will be 3840 meters (4160 yards; 240m (260 yards) for each exclosure). Holding the fence in place will be 1280 metal fence posts (80 for each exclosure). A total of 270 80-LB bags

of cement will be use to secure some fence posts (18 bags for 18 posts at each exclosure).

In addition, approximately five to 70 metal tree tags may be used at each exclosure and reference area. Potentially, a total of 1540 metal tree tags could be used across the exclosures and reference areas in mixed conifer and La Mesa grassland habitats.

Placement of metal stakes and use of other data collection equipment (i.e. for measurement of soil erosion and soil moisture) in the wilderness will impact wilderness values. Cameras, field data recorder, calculators, computers, and other tools of research will be mechanical intrusions into Wilderness. These degradations of Wilderness are needed to gain information to protect park resources from permanent damage and loss.

Helicopters create a temporary but highly visible and audible impact in Wilderness. Depending on the lifting power of the helicopter and flight conditions, approximately 10 helicopter trips will be needed to supply each study site with the needed construction materials. One or two additional helicopter trips will be needed to remove scrap materials after construction.

A total of approximately 176 helicopter trips will be needed to move construction materials. Of these trips, approximately 44 will enter or cross semi-pristine zones, 99 will enter or cross primitive zones, 22 will enter or cross semi-primitive zones, and 66 will enter or cross transition zones. Approximately 121 helicopter trips will cross front-country areas. On average, each trip will last approximately 15 minutes for a total of approximately 44 hours of flight time.

Considering the weight of the materials, the health and safety risks associated with transporting 12-foot poles, 330-foot long rolls of fence, and cement and water by hand or horseback, and on-trail and off-trail impacts from horses and people moving the needed materials, helicopter use is considered the minimum tool for the job (although undesirable).

Use of a gas-powered auger to drill post holes will create a temporary impact on the Wilderness experience of some visitors. However, the auger noise should not travel great distances -- typically not audible at distances of greater than 150 yards.

A small amount of chainsaw use will be need to clear a path for the fence at each exclosure site. Hand saws and hand clippers will be used whenever small branch wood is involved. Chainsaws will only be used for large diameter wood removal. Cut stumps can also be an offensive intrusion in Wilderness. This intrusion

will be mitigated by covering and flush-cutting stumps and branches, and by rubbing dirt into cut wood surfaces.

The ungulate exclosures will be dismantled and all materials removed from the wilderness at the conclusion of the project or when no longer needed in support of piñon-juniper restoration activities or elk management research or actions. In all likelihood, the exclosures will serve management needs for decades. Thus, these wilderness intrusions could persist for many years beyond the initial four-year research program.

Data collection activities are an essential component of the proposed project, providing the scientific basis necessary to evaluate elk impacts to ecosystem processes and wildlife species. Placement of stakes and establishment of various research projects in the Bandelier backcountry can have a cumulative adverse effect upon park values. In response, the park restricts casual placement of metal stakes in the backcountry, requiring all proposed research and collecting efforts to be reviewed through natural and cultural compliance procedures as well as to comply with newly revised guidelines for research and collecting at Bandelier.

PROPOSED ACTION (ALTERNATIVE 3)

The same as Alternative 2 and at piñon-juniper sites, short-term (5-10 years) negative changes in the aesthetic appearance from overstory removal / slash mulch treatments. The proposed overstory removal at piñon-juniper sites will alter the character and feel of the current wilderness landscape in areas where the treatment is visible. Overstory removal will present the appearance of a fuel-wooding operation and will leave cut logs, slash and stumps on site. The negative aesthetic effects of overstory removal (i.e. cut trees and slash) are relatively short-lived (i.e. 5-10 years), whereas the long-term benefits to the health and stability of the ecosystem are enormous

Many areas set aside as wilderness were seriously impaired by historical land uses prior to legislative protection. Left alone, many degraded areas will not heal themselves. This appears to be the case with degraded piñon-juniper woodlands at Bandelier. Accelerated erosional processes, if left unchecked, are expected to transform lower elevations of Bandelier into bedrock badlands within 100 years. NPS policy and guidelines directs park managers to restore degraded lands where appropriate and in a manner consistent with other applicable laws and regulations.

At piñon-juniper sites, chainsaw use will create unavoidable short-term impacts on visitor use and wilderness values, but the

timing and duration of overstory removal will minimize these impacts. Chainsaw noise will be noticeable to hikers walking through off-trail areas and established park trails near each piñon-juniper study site for a few days during September and October 1997. The visitor center will be notified of the overstory removal schedule so that backcountry users can be notified and avoid areas with possible construction sounds. The total duration of chainsaw work is expected to be approximately one month with a four- to six-person crew.

Chainsaws were determined to be the minimum tool after consideration of 1) relative noise impacts on visitors and T&E species, 2) the feasibility and safety of using manual tools to implement overstory removal treatments, and 3) the additional time required if manual tools (i.e. axes and hand saws) were used. Chainsaws come equipped with mufflers to suppress noise; additional noise suppression in forestry grade saws is not possible without significant loss of power.

Issues of practicality and safety are major considerations in the decision to use chainsaws for implementation of the overstory removal. One-seed juniper is difficult to cut efficiently or safely using hand tools both because its growth form is very irregular and brushy, being multi-stemmed from the base, and because the wood is relatively sappy and hard. In addition, it will be impossible to flush cut stumps close to the ground and minimize the aesthetic impacts of tree removal. Finally, the use of manual tools will at least quadruple the time that will be required to implement overstory removal.

Data collection activities would be the same as for Alternative 2 and are an essential component of the proposed project, providing the scientific basis necessary to evaluate elk impacts to ecosystem processes and wildlife species, as well as the success of overstory removal and slash mulching.

WILDLIFE

NO ACTION (ALTERNATIVE 1)

Long-term degradation of habitats in all areas of the park will result in unknown consequences on wildlife species.

PARTIAL ACTION (ALTERNATIVE 2)

Wildlife habitat for a variety of species should be improved in and around exclosure sites. Wildlife habitat should improve within exclosure areas due to increased structural complexity in both grassland and forest communities. In order to gain more detailed information on the response of individual species, this

project will document the effect of overstory removal on bird, small mammal, and arthropod abundance and diversity. In addition, ungulate utilization of sites will be compared using pellet count and vegetation biomass measures inside exclosures and at reference areas. Birds will be sampled using an avian point count method and nest searches. Lepidoptera larvae will be collected and reared to adults for identification and then killed for museum storage. Ground-dwelling arthropods will be destructively sampled using pit traps with non-toxic propylene-glycol as a collection trap medium. Propylene-glycol may be slightly attractive to browsing mammals such as deer, but Material Safety Data Sheet information indicates the product has low toxicity to a range of species tested. Traps will be fitted with a camouflage cover to discourage accidental discovery and consumption of the propylene-glycol by wildlife.

PROPOSED ACTION (ALTERNATIVE 3)

Same as Alternative 2 and enhancement of habitat and food base is likely for many species through increased site productivity after overstory removal at piñon-juniper sites. Little information, however, is available to detail expected responses from individual species. Some species may benefit while other species may suffer. Some species, such as the gray vireo (*Vireo vicinior*) preferring dense, closed woodland stands of piñon-juniper may be negatively impacted by restoration of the treatment watershed. (The gray vireo has been reported but not confirmed in the park.) The piñon-juniper exclosure sites will, however, only constitute a very limited opening in a wide expanse of woodland area.

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